

## **SUBCHAPTER I : GROUND-WATER MONITORING AND CORRECTIVE ACTION**

### **§330.230. Applicability.**

(a) The requirements in this subchapter apply to all Municipal Solid Waste Landfills (MSWLF) units, except as provided in §330.3(e) of this title (relating to Applicability), in §330.239 of this title (relating to Ground-Water Monitoring at Type IV Landfills), in §330.240 of this title (relating to Ground-Water Monitoring at Other Types of Landfills and Facilities), and in subsection (b) of this section.

(b) Ground-water monitoring requirements under §§330.231-330.235 of this title (relating to Ground-Water Monitoring and Corrective Action) may be suspended by the executive director for a MSWLF unit if the owner or operator can demonstrate that there is no potential for migration of hazardous constituents from that MSWLF unit to the uppermost aquifer as defined in §330.2 of this title (relating to Definitions) during the active life and the closure and post-closure care period of the unit. This demonstration shall be certified by a qualified ground-water scientist and approved by the executive director, and shall be based upon:

(1) site-specific field-collected measurements, sampling, and analysis of physical, chemical, and biological processes affecting contaminant fate and transport; and

(2) contaminant fate and transport predictions that maximize contaminant migration and consider impacts on human health and the environment.

(c) Owners and operators of MSWLF units shall comply with the ground-water monitoring requirements of this subchapter according to the following schedule unless an alternative schedule is specified under subsection (d) of this section. Not later than the applicable effective date, the owner or operator shall submit a certification that the system is in compliance with §330.231 of this title (relating to Ground-Water Monitoring Systems). The certification shall be submitted not later than the applicable effective date, unless a later date is approved by the executive director in writing.

(1) Owners or operators of existing MSWLF units that have ground-water monitoring systems in place prior to the effective date of these regulations shall continue the monitoring programs in accordance with regulations in effect prior to October 9, 1993, and the applicable permit provisions until the earliest of the effective dates of paragraphs (2), (3), or (4) of this subsection, §330.230(d) of this title (relating to Applicability), or the effective date of the Ground-Water Sampling and Analysis Plan described in §330.233 of this title (relating to Ground-Water Sampling and Analysis Requirements).

(2) Owners or operators of existing MSWLF units and lateral expansions less than one mile from a drinking-water intake as defined in §330.2 of this title (relating to Definitions) shall submit to the executive director a documented certification signed by a qualified ground-water scientist that the facility is in compliance with the ground-water monitoring requirements specified in

§§330.231-330.235 of this title (relating to Ground-Water Monitoring and Corrective Action) by October 9, 1994.

(3) Owners or operators of existing MSWLF units and lateral expansions more than one mile but less than two miles from a drinking-water intake shall submit to the executive director a documented certification signed by a qualified ground-water scientist that the facility is in compliance with the ground-water monitoring requirements specified in §§330.231-330.235 of this title (relating to Ground-Water Monitoring and Corrective Action) by October 9, 1995.

(4) Owners or operators of existing MSWLF units and lateral expansions more than two miles from a drinking-water intake shall submit to the executive director a documented certification signed by a qualified ground-water scientist that the facility is in compliance with the ground-water monitoring requirements specified in §§330.231-330.235 of this title (relating to Ground-Water Monitoring and Corrective Action) by October 9, 1996.

(5) Owners or operators of new MSWLF units shall submit to the executive director a documented certification signed by a qualified ground-water scientist that the facility is in compliance with the ground-water monitoring requirements specified in §§330.231-330.235 of this title (relating to Ground-Water Monitoring and Corrective Action) before waste can be placed in the unit.

(d) The executive director may specify an alternative schedule for the owners or operators of existing MSWLF units and lateral expansions to comply with ground-water monitoring requirements specified in §§330.231-330.235 of this title (relating to Ground-Water Monitoring and Corrective Action). This schedule will ensure that 50 percent of all existing MSWLF units are in compliance by October 9, 1994, and that all existing MSWLF units are in compliance by October 9, 1996. The following factors must be considered in determining any potential risks to human health and the environment posed by a MSWLF unit proposed for an alternative compliance schedule:

- (1) proximity of human and environmental receptors;
- (2) design of the MSWLF unit;
- (3) age of the MSWLF unit;
- (4) size of the MSWLF unit;
- (5) types and quantities of wastes disposed including sewage sludge; and
- (6) resource value of the underlying aquifer including current and future uses, proximity and withdrawal rate of users, and ground-water quality and quantity.

(e) Once established at a MSWLF unit, ground-water monitoring shall be conducted throughout the active life and post-closure care period of that MSWLF unit as specified in §330.254 of this title (relating to Post-Closure Care Maintenance Requirements).

**§330.231. Ground-Water Monitoring Systems.**

(a) A ground-water monitoring system shall be installed that consists of a sufficient number of monitoring wells, installed at appropriate locations and depths, to yield representative ground-water samples from the uppermost aquifer as defined in §330.2 of this title (relating to Definitions).

(1) Background wells shall be installed to allow determination of the quality of background ground water that has not been affected by leakage from a unit. A determination of background quality may include sampling of wells that are not hydraulically upgradient of the waste management area if hydrogeologic conditions do not allow the owner or operator to determine which wells are hydraulically upgradient or if sampling at other wells will provide a better indication of background ground-water quality than is possible from upgradient wells.

(2) The downgradient monitoring system shall include monitoring wells installed to allow determination of the quality of ground water passing the relevant point of compliance as defined in §330.2 of this title (relating to Definitions). The downgradient monitoring system shall be installed to ensure the detection of ground-water contamination in the uppermost aquifer. When physical obstacles preclude installation of the ground-water monitoring wells at existing units, the wells may be installed at the closest practicable distance hydraulically downgradient from the relevant point of compliance as defined in §330.2 of this title (relating to Definitions) that will ensure detection of ground-water contamination of the uppermost aquifer.

(b) The executive director may approve a multi-unit ground-water monitoring system instead of separate ground-water monitoring systems for each MSWLF unit when the facility has several units, provided the multi-unit system meets the requirement of subsection (a) of this section and will be as protective of human health and the environment as individual monitoring systems for each MSWLF unit, based on the following factors:

- (1) number, spacing, and orientation of the Municipal Solid Waste Landfills (MSWLF) units;
- (2) hydrogeologic setting;
- (3) site history;
- (4) engineering design of the Municipal Solid Waste Landfills (MSWLF) units; and
- (5) type of waste accepted at the MSWLF units.

(c) The executive director may approve an alternative design for a ground-water monitoring system that uses other means in conjunction with monitoring wells to ensure detection of ground-water contamination in the uppermost aquifer from a MSWLF unit. The alternative design shall be at least as protective of human health and the environment as a monitoring-well system as specified in §330.231(a) of this title (relating to Ground-Water Monitoring Systems).

(d) Monitoring wells shall be constructed in accordance with the rules of the commission and §330.242 of this title (relating to Monitor-Well Construction Specifications). Monitoring-well construction shall provide for maintenance of the integrity of the bore hole, collection of representative ground-water samples from the water-bearing zone(s) of concern, and prevention of migration of ground water and surface water within the bore hole.

(1) Within 30 days of the completion of a monitoring well or any other part of a monitoring system, details of its construction shall be submitted to the executive director and shall include, as appropriate, a detailed geologic log of the boring, a description of development procedures, a detailed location map drawn to scale showing the relationship of the well to the MSWLF unit and relevant point(s) of compliance, and any other data obtained during installation or construction of the well or system.

(2) All parts of a ground-water monitoring system shall be operated and maintained so that they perform at least to design specifications through the life of the ground-water monitoring program.

(e) A ground-water monitoring system, including the number, spacing, and depths of monitoring wells or other sampling points, shall be designed and certified by a qualified ground-water scientist. Within 14 days of the certification, the owner or operator must submit the certification to the executive director and place a copy of the certification in the operating record. The plan for the monitoring system and all supporting data shall be submitted to the executive director for review and approval prior to construction.

(1) The design of a monitoring system shall be based on site-specific technical information that must include a thorough characterization of: aquifer thickness; ground-water flow rate; ground-water flow direction including seasonal and temporal fluctuations in flow; effect of site construction and operations on ground-water flow direction and rates; and thickness, stratigraphy, lithology, and hydraulic characteristics of saturated and unsaturated geologic units and fill materials overlying the uppermost aquifer, materials of the uppermost aquifer, and materials of the lower confining unit of the uppermost aquifer. A geologic unit is any distinct or definable native rock or soil stratum.

(2) Ground-water modeling may be used to supplement the determination of the spacing of monitoring wells or other sampling points and shall consider site-specific characteristics of ground-water flow as well as dispersion and diffusion of possible contaminants in the materials of the uppermost aquifer. Any model used shall:

(A) have supporting documentation that establishes its ability to represent ground-water flow and contaminant transport, as needed;

(B) have a sound set of equations based on accepted theory representing ground-water movement and contaminant transport;

(C) have numerical solution methods that are based on sound mathematical principles and supported by verification and checking techniques;

(D) be calibrated against site-specific field data;

(E) have a sensitivity analysis to measure its response to changes in the values of major parameters, error tolerances, and other parameters;

(F) show mass-balance calculations, where necessary; and

(G) be based on actual field or laboratory measurements, or equivalent methods, that document the validity of chosen parameter values.

(3) the owner or operator of a MSWLF unit or facility shall promptly notify the executive director in writing of changes in site construction or operation or changes in adjacent property that affect or are likely to affect the direction and rate of ground-water flow and the potential for detecting ground-water contamination from a MSWLF unit and that may require the installation of additional monitoring wells or sampling points. Such additional wells or sampling points require a modification of the Site Development Plan.

#### **§330.233. Ground-Water Sampling and Analysis Requirements.**

(a) The ground-water monitoring program shall include consistent sampling and analysis procedures that are designed to ensure monitoring results that provide an accurate representation of ground-water quality at the background and downgradient wells, or other monitoring system, installed in compliance with §330.231(a)-(c) of this title (relating to Ground-Water Monitoring Systems).

(b) The owner or operator shall submit a ground-water sampling and analysis plan (GWSAP) to the executive director for review and approval prior to commencement of sampling and shall maintain a current copy in the operating record. The GWSAP shall be a part of the Site Development Plan (SDP); if necessary, the owner or operator shall obtain a modification of the SDP to incorporate the GWSAP. The GWSAP shall:

(1) include procedures and techniques for sample collection, sample preservation and shipment, analytical procedures, chain of custody controls, and quality assurance and quality control;

(2) provide for measurement of ground-water elevations at each sampling point prior to bailing or purging; measurement at an event shall be accomplished over a period of time short enough to avoid temporal variations in water levels; sampling at each event shall proceed from the point with the highest water-level elevation to those with successively lower elevations unless contamination is known to be present, in which case wells not likely to be contaminated shall be sampled prior to those that are known to be contaminated unless an alternative procedure is approved by the executive director; and

(3) include sampling and analytical methods that are appropriate for ground-water sampling and that accurately measure hazardous constituents and other monitoring parameters in ground-water samples. The number of samples to be collected to establish ground-water quality data shall be consistent with the appropriate statistical procedures determined pursuant to subsection (g) of this section. The sampling procedures shall be those specified under §330.234(b) of this title (relating to Detection Monitoring Program) for detection monitoring, §330.235(b)-(d) of this title (relating to Assessment Monitoring Program) for assessment monitoring, and §330.236(b) of this title (relating to Assessment of Corrective Measures) for corrective action.

(c) Ground-water samples shall not be field-filtered prior to laboratory analysis for the constituents listed in §330.241 of this title (relating to Constituents for Detection Monitoring). Field-filtering may be used on other samples if authorized in writing by the executive director.

(d) The sampling procedures and frequency shall be protective of human health and the environment.

(e) The owner or operator shall establish background ground-water quality in hydraulically upgradient wells or in background wells for each of the monitoring parameters or constituents required in the ground-water monitoring program for a MSWLF unit, as determined under §330.234(a) of this title (relating to Detection Monitoring Program) or §330.235(a) of this title (relating to Assessment Monitoring Program) and pursuant to §330.231(a)(1) of this title (relating to Ground-Water Monitoring Systems). Downgradient ground-water data shall not be adjusted by subtracting background ground-water data.

(f) The owner or operator shall specify in the GWSAP one or more of the following statistical methods to be used in evaluating ground-water monitoring data for each parameter or constituent analyzed as required under §330.234 of this title (relating to Detection Monitoring Program) and §330.235 of this title (relating to Assessment Monitoring Program). The statistical test(s) chosen shall be conducted separately for each tested constituent in each well or sampling point.

(1) A parametric analysis of variance (ANOVA) followed by multiple-comparisons procedures to identify statistically significant evidence of contamination. The method shall include estimation and testing of the contrasts between each downgradient well's mean and the background mean levels for each constituent.

(2) An analysis of variance (ANOVA) based on ranks followed by multiple-comparisons procedures to identify statistically significant evidence of contamination. The method shall include estimation and testing of the contrasts between each downgradient well's median and the background median levels for each constituent.

(3) A tolerance or prediction interval procedure in which an interval for each constituent is established from the distribution of the background data and the level of each constituent in each downgradient well is compared to the upper tolerance or prediction limit.

(4) A control-chart approach that gives control limits for each constituent.

(5) Another statistical test method that meets the performance standards of subsection (g) of this section. The owner or operator shall submit to the executive director satisfactory justification for this alternative test.

(g) Any statistical method chosen under subsection (f) of this section shall comply with the following performance standards, as appropriate.

(1) The statistical method used to evaluate ground-water monitoring data shall be appropriate for the distribution of tested constituents. If the distribution of a tested constituent is shown by the owner or operator to be inappropriate for a normal theory test, then the data should be transformed or a distribution-free theory test should be used. If the distributions for the constituents differ, more than one statistical method may be needed.

(2) If an individual well (or sampling point) comparison procedure is used to compare an individual compliance well constituent concentration with background constituent concentrations or a ground-water protection standard, the test shall be done at a Type I error level no less than 0.01 for each testing period. If a multiple-comparisons procedure is used, each testing period shall be no less than 0.05, but the Type I error of no less than 0.01 for individual well comparisons shall be maintained. This performance standard does not apply to tolerance intervals, prediction interval, or control charts.

(3) If a control-chart approach is used to evaluate ground-water monitoring data, the specific type of control chart and its associated parameter values shall be protective of human health and the environment. These parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

(4) If a tolerance interval or a prediction interval is used to evaluate ground-water monitoring data, the levels of confidence, and for tolerance intervals the percentage of the population that the interval must contain, shall be protective of human health and the environment. These parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentration values for each constituent of concern.

(5) The statistical method shall account for data below the limit of detection with one or more statistical procedures that are protective of human health and the environment. Any practical quantitation limit (pql or PQL) that is used in the statistical method shall be the lowest concentration level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions that are available to the facility.

(6) If necessary, the statistical method shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data.

(h) The owner or operator shall determine within a reasonable period of time after completing sampling and analysis whether or not there is evidence of a statistically significant change from background values for each constituent required in the ground-water monitoring program for a Municipal Solid Waste Landfills (MSWLF) unit, as determined under §330.234(a) or §330.235(a) of

this title (relating to Detection Monitoring Program or Assessment Monitoring Program). In determining if there is evidence of a statistically significant change from background, the owner or operator shall compare the ground-water quality of each tested constituent at each monitoring well or other sampling points designated pursuant to §330.231(a)(2) of this title (relating to Ground-Water Monitoring Systems) to the background value of that constituent, according to the statistical procedures and performance standards specified under subsections (f) and (g) of this section.

**§330.234. Detection Monitoring Program.**

(a) Detection monitoring is required at MSWLF units from all ground-water monitoring wells defined under §330.231(a)(1)-(2) of this title (relating to Ground-Water Monitoring Systems). At a minimum, a detection monitoring program shall include the monitoring for the constituents listed in §330.241 of this title (relating to Constituents for Detection Monitoring).

(1) The executive director may delete any of the constituents listed in §330.241 of this title (relating to Constituents for Detection Monitoring) for a MSWLF unit if it can be documented that the removed constituents are not reasonably expected to be in or derived from the waste contained in the unit.

(2) The executive director may establish an alternative list of inorganic indicator constituents for a Municipal Solid Waste Landfills (MSWLF) unit in lieu of some or all of the heavy metals (constituents 1-15 in §330.241 of this title (relating to Constituents for Detection Monitoring)) if the alternative constituents provide a reliable indication of inorganic releases from the MSWLF unit to the ground water. The executive director may also add inorganic or organic constituents to those to be tested if they are reasonably expected to be in or derived from the waste contained in the unit or if they are likely to provide a useful indication of releases from the MSWLF unit to the ground water. In determining alternative or additional constituents, the executive director shall consider the following factors:

(A) the types, concentrations, quantities, and persistence of waste constituents in wastes at the MSWLF unit;

(B) the mobility, stability, and persistence of waste constituents or their reaction products in the unsaturated and saturated zones adjacent to or beneath the MSWLF unit;

(C) the detectability of indicator constituents, waste constituents, and reaction products in the ground water; and

(D) the concentrations and coefficients of variation of monitoring parameters or constituents in the ground-water background.

(b) The monitoring frequency for all constituents listed in §330.241 of this title (relating to Constituents for Detection Monitoring) , or in the alternative list established pursuant to subsection (a)(2) of this section, shall be at least semiannual during the active life of the facility and the closure and post-closure care period.



(1) A minimum of four statistically independent samples from each background and each downgradient well shall be collected and analyzed for the constituents listed in §330.241 of this title (relating to Constituents for Detection Monitoring), or the alternative list established pursuant to subsection (a)(2) of this section, during the first semiannual sampling event. The independence of the four samples shall be achieved by bailing or purging at least three well volumes (or to dryness, if less) from each well before each of the four samples is collected. The executive director may authorize alternate procedures for slow-recharging monitoring wells. At least one sample from each background and downgradient well shall be collected and analyzed during each subsequent semiannual sampling event.

(2) The executive director may specify an appropriate alternative frequency for repeated sampling and analysis of the constituents listed in §330.241 of this title (relating to Constituents for Detection Monitoring), or in the alternative list established pursuant to subsection (a)(2) of this section, during the active life and the closure and post-closure care period. The alternative frequency shall be no less than annual and shall be based on factors such as lithology and hydraulic conductivity of the aquifer and unsaturated zone, ground-water flow rates, minimum distance of travel from waste to monitoring wells, and resource value of the uppermost aquifer.

(3) For the purpose of establishing background ground-water quality, the executive director may agree to consider analytical data acquired prior to the effective date of this title in addition to the data required in this subsection and in subsection §330.235(b) of this title (relating to Assessment Monitoring Program).

(c) Not later than 45 days after each sampling event, the owner or operator shall submit to the executive director a report containing the results of the analyses.

(d) Not later than 60 days after each sampling event, the owner or operator shall notify the executive director in writing if there has been a statistically significant change from background of any tested constituent at any monitoring well.

(1) If a statistically significant change from background of any tested constituent at any monitoring well has occurred, the owner or operator shall immediately place a notice in the operating record describing the increase and shall establish an assessment monitoring program meeting the requirements of §330.235 of this title (relating to Assessment Monitoring Program) within 90 days of the date of the notice to the executive director required under subsection (d) of this section, except as provided for in paragraph (2) of this subsection.

(2) If a statistically significant change from background of any tested constituent at any monitoring well has occurred and the owner or operator has reasonable cause to think that a source other than a MSWLF unit caused the contamination or that the statistically significant change resulted from error in sampling, analysis, statistical evaluation, or natural variation in ground-water quality, then the owner or operator may submit a report providing documentation to this effect. The report shall be prepared and certified by a qualified ground-water scientist and submitted to the executive director for review and approval not later than 90 days after the sampling event. If no such demonstration satisfactory to the executive director has been made within 90 days after the sampling event, the owner

or operator shall initiate an assessment monitoring program as required in paragraph (1) of this subsection.

**§330.235. Assessment Monitoring Program.**

(a) Assessment monitoring is required whenever a statistically significant change from background has been detected for one or more of the constituents listed in §330.241 of this title (relating to Constituents for Detection Monitoring), or in the alternative list established pursuant to §330.234(a) (2) of this title (relating to Detection Monitoring Program), and this constitutes triggering.

(b) Within 90 days of triggering an assessment monitoring program in accordance with §330.234(d) of this title (relating to Detection Monitoring Program), and not less than annually thereafter, the owner or operator shall sample and analyze the ground-water monitoring system for all constituents identified in paragraph (1) of this subsection.

(1) The constituents to be analyzed in samples collected pursuant to subsection (b) of this section shall be those listed in Appendix II to 40 Code of Federal Regulation Part 258 and those in the alternative list established pursuant to §330.234(a)(2) of this title (relating to Detection Monitoring Program). All of these constituents are hereinafter referred as "assessment constituents." Appendix II to 40 Code of Federal Regulation Part 258, effective October 9, 1993, is herein adopted by reference.

(2) A minimum of one sample shall be collected from each well and analyzed for the assessment constituents during each new sampling event. For any constituent(s) detected in the downgradient wells as a result of the analysis of the assessment constituents, a minimum of four statistically independent samples from each background and downgradient well shall be collected and analyzed to establish background levels for the constituent(s). The executive director may specify an appropriate subset of wells to be sampled and analyzed for the assessment constituents during assessment monitoring and may delete any of the assessment constituents for a Municipal Solid Waste Landfills (MSWLF) unit if it can be documented that the removed constituents are not reasonably expected to be in or derived from the waste contained in the unit.

(c) The executive director may specify an appropriate alternative frequency for repeated sampling and analysis for the assessment constituents required by subsection (b) of this section during the active life and the closure and post-closure care period of the unit. The alternative frequency shall be no less than annual and shall be based on factors such as lithology and hydraulic conductivity of the aquifer and unsaturated zone, ground-water flow rates, minimum distance of travel from the waste nearest to any downgradient monitoring well, resource value of the uppermost aquifer, and nature (fate and transport) of any constituents detected in response to this section.

(d) Not later than 45 days after each sampling event, the owner or operator shall submit to the executive director the results from the initial and subsequent sampling events required in subsection (b) of this section and also place them in the operating record. The owner or operator shall also:

(1) within 90 days of submittal of the results from a sampling event and on at least a semiannual basis thereafter, resample all wells specified by §330.231(a) of this title (relating to

Ground-Water Monitoring Systems) and conduct analyses for all constituents in §330.241 of this title (relating to Constituents for Detection Monitoring) or in the alternative list established pursuant to §330.234(a)(2) of this title (relating to Detection Monitoring Program) and for those constituents in Appendix II of 40 CFR Part 258 that are detected in response to subsection (b) of this section. The results shall be submitted to the executive director not later than 45 days after the sampling event and shall also be placed in the operating record. At least one sample shall be collected and analyzed from each background and downgradient well at each sampling event. The executive director may specify an alternative monitoring frequency during the active life and the closure and post-closure care period for the constituents referred to in this paragraph. The alternative frequency for constituents in §330.241 of this title (relating to Constituents for Detection Monitoring), or the alternative list established pursuant to §330.234(a)(2) of this title (relating to Detection Monitoring Program), during the active life and the closure and post-closure care period shall be not less than annual. The alternative frequency shall be based on consideration of the factors described in subsection (c) of this section;

(2) establish background concentrations for any constituents detected pursuant to subsection (b) of this section or paragraph (1) of this section;

(3) establish ground-water protection standards for all constituents in downgradient wells detected pursuant to subsection (b) of this section or paragraph (1) of this subsection. The ground-water protection standards shall be established in accordance with subsection (h) or (i) of this section.

(e) If the concentrations of all assessment constituents are shown to be at or below background values, using the statistical procedures in §330.233(g) of this title (relating to Ground-Water Sampling and Analysis Requirements) for two consecutive sampling events, the owner or operator must notify the executive director in writing and return to detection monitoring if approved.

(f) If the concentrations of any assessment constituents are above background values, but all concentrations are below the ground-water protection standard established under subsection (h) or (i) of this section, using the statistical procedures in §330.233(g) of this title (relating to Ground-Water Sampling and Analysis Requirements), the owner or operator shall continue assessment monitoring in accordance with this section.

(g) If one or more assessment constituents are detected at statistically significant levels above the ground-water protection standard established under subsection (h) or (i) of this section in any sampling event, the owner or operator shall notify the executive director and appropriate local government officials in writing and place a notice in the operating record within 60 days of the sampling event identifying the assessment constituents that have exceeded the ground-water protection standard.

(1) The owner or operator shall also:

(A) characterize the nature and extent of the release by installing additional monitoring wells as necessary;

(B) install at least one additional monitoring well at the facility boundary in the direction of contaminant migration and sample this well in accordance with §330.235(d)(1) of this title (relating to Assessment Monitoring Program);

(C) notify in writing all persons who own or occupy the land that directly overlies any part of the plume of contamination if contaminants have migrated off-site as indicated by sampling of wells in accordance with paragraph (d)(1) of this section; and

(D) initiate an assessment of corrective measures as required by §330.236 of this title (relating to Assessment of Corrective Measures) all within 90 days of the notice to the executive director.

(2) The owner or operator may demonstrate that a source other than a MSWLF unit caused the contamination or that the statistically significant change resulted from error in sampling, analysis, statistical evaluation, or natural variation in ground-water quality. A report documenting this demonstration shall be prepared and certified by a qualified ground-water scientist and submitted to the executive director for review and approval, and shall be placed in the operating record. If a successful demonstration is made, the owner or operator shall continue monitoring in accordance with the assessment monitoring program pursuant to this section and may return to detection monitoring if the assessment constituents are at or below background as specified in subsection (e) of this section. Until a successful demonstration is made, the owner or operator shall comply with paragraph (1) of this subsection including initiating an assessment of corrective measures.

(h) The owner or operator shall establish a ground-water protection standard for each assessment constituent detected in the down-gradient monitoring wells. The ground-water protection standard shall be:

(1) for constituents for which a maximum contaminant level (MCL) has been promulgated under section 1412 of the Safe Drinking Water Act (codified) under 40 Code of Federal Regulation Part 141, the MCL for that constituent;

(2) for constituents for which MCLs have not been promulgated, the background concentration for the constituent established from wells in accordance with §330.231(a)(1) of this title (relating to Ground-Monitoring Systems); or

(3) for constituents for which the background level is higher than the MCL identified under paragraph (1) of this subsection or health-based levels identified under subsection (i) of this section, the background concentration.

(i) The executive director may establish an alternative ground-water protection standard for assessment constituents for which MCLs have not been established. These ground-water protection standards shall be appropriate health-based levels that satisfy the following criteria:

(1) the level is derived in a manner consistent with Environmental Protection Agency guidelines for assessing the health risks of environmental pollutants (51 FR 33992, 34006, 34014, 34028, September 24, 1986);

(2) the level is based on scientifically valid studies conducted in accordance with the Toxic Substances Control Act Good Laboratory Practice Standards (40 Code of Federal Regulation Part 792) or equivalent;

(3) for carcinogens, the level represents a concentration associated with an excess lifetime cancer risk level (due to continuous lifetime exposure) with the  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  range; and

(4) for systemic toxicants, the level represents a concentration to which the human population (including sensitive subgroups) could be exposed to on a daily basis that is likely to be without appreciable risk of deleterious effects during a lifetime. For purposes of this subchapter, systemic toxicants include toxic chemicals that cause effects other than cancer or mutation.

(j) In establishing ground-water protection standards under subsection (i) of this section, the executive director may consider multiple contaminants in the ground water, exposure threats to sensitive environmental receptors, and other site-specific exposure or potential exposure to ground water.

#### **§330.236. Assessment of Corrective Measures.**

(a) Within 90 days of finding that any of the assessment constituents have been detected at a statistically significant level exceeding the ground-water protection standards defined under §330.235(h) or (i) of this title (relating to Assessment Monitoring Program), the owner or operator shall initiate an assessment of corrective measures. Such an assessment shall be completed within a reasonable period of time approved by the executive director.

(b) The owner or operator shall continue to monitor in accordance with the assessment monitoring program as specified in §330.235 of this title (relating to Assessment Monitoring Program).

(c) The assessment shall include an analysis of the effectiveness of potential corrective measures in meeting all of the requirements and objectives of the remedy as described under §330.237 of this title (relating to Selection of Remedy), addressing at least the following:

(1) performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to any residual contamination;

(2) time required to begin and complete the remedy;

(3) costs of remedy implementation; and

(4) institutional requirements such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy or remedies.

(d) The owner or operator shall discuss the results of the corrective measures assessment, prior to the selection of a remedy, in a public meeting with interested and affected parties. The owner or operator shall arrange for the meeting and provide notice in accordance with the provisions of §305.107(c) of this title (relating to Public Meeting and Notification Requirements).

**§330.237. Selection of Remedy.**

(a) Based on the results of the corrective measures assessment conducted under §330.236 of this title (relating to Assessment of Corrective Measures), the owner or operator shall select a remedy that, at a minimum, meets the standards listed in subsection (b) of this section and is in accordance with rules of the commission. Within 30 days of completing the assessment of corrective action described in §330.236 of this title (relating to Assessment of Corrective Measures), the owner or operator shall submit a report to the executive director for review and approval and place it in the operating record. The report shall describe the remedy or remedies proposed for selection and the way it or they meet the standards in subsection (b) of this section.

(b) Remedies shall:

(1) be protective of human health and the environment;

(2) attain the ground-water protection standard as specified pursuant to §330.235(h) or (i) of this title (relating to Assessment Monitoring Program);

(3) control the source(s) of releases so as to reduce or eliminate, to the maximum extent practicable, further releases of assessment constituents into the environment that may pose a threat to human health or the environment; and

(4) comply with standards for management of wastes as specified in §330.238(d) of this title (relating to Implementation of the Corrective Action Program).

(c) In selecting a remedy that meets the standards of subsection (b) of this section, the owner or operator shall consider the following evaluation factors:

(1) long-and short-term effectiveness and protectiveness of the potential remedy, along with the degree of certainty that the remedy will prove successful based on consideration of:

(A) magnitude of reduction of existing risks;

(B) magnitude of residual risks in terms of likelihood of further releases due to waste remaining following implementation of a remedy;

(C) type and degree of long-term management required, including monitoring, operation, and maintenance;

(D) short-term risks that might be posed to the community, workers, or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, redisposal, or containment;

(E) time until full protection is achieved;

(F) potential for exposure of humans and environmental receptors to remaining wastes, considering potential threats to human health and the environment associated with excavation, transportation, redisposal, or containment;

(G) long-term reliability of the engineering and institutional controls; and

(H) potential need for replacement of the remedy;

(2) effectiveness of the remedy in controlling the source to reduce further releases based on the extent to which containment practices will reduce further releases and the extent to which treatment technologies may be used;

(3) ease or difficulty of implementing a potential remedy based on consideration of

(A) degree of difficulty associated with constructing the technology;

(B) expected operational reliability of the technologies;

(C) need to coordinate with and obtain necessary approvals and permits from other agencies and regulatory bodies;

(D) availability of necessary equipment and specialists; and

(E) available capacity and location of needed treatment, storage, and disposal services;

(4) practicable capability of the owner or operator, including a consideration of the technical and economic capability;

(5) degree to which community concerns are addressed by a potential remedy.

(d) The owner or operator shall specify as part of the selected remedy a schedule for initiating and completing remedial activities. The schedule shall require the initiation of remedial activities within a reasonable time approved by the executive director, taking into consideration the factors set forth in paragraphs (1)-(8) of this subsection. The owner or operator shall consider the following factors in determining the schedule:

- (1) extent and nature of contamination;
  - (2) practical capabilities of remedial technologies in achieving compliance with ground-water protection standards established under §330.235(h) or (i) of this title (relating to Assessment Monitoring Program) and other objectives of the remedy;
  - (3) availability of treatment or disposal capacity for wastes managed during implementation of the remedy;
  - (4) desirability of utilizing technologies that are not currently available but which may offer significant advantages over available technologies in terms of effectiveness, reliability, safety, or ability to achieve remedial objectives;
  - (5) potential risks to human health and the environment from exposure to contamination prior to completion of the remedy;
  - (6) resource value of the aquifer including current and future uses; proximity and withdrawal rate of users; ground-water quantity and quality; potential damage to wildlife, crops, vegetation, and physical structures from exposure to waste constituents; hydrogeologic characteristics of the facility and adjacent land; ground-water removal and treatment costs; and cost and availability of alternative water supplies;
  - (7) practicable capability of the owner or operator; and
  - (8) other relevant factors.
- (e) The executive director may determine that remediation of a release of an assessment constituent from a MSWLF unit is not necessary if the owner or operator demonstrates to the satisfaction of the executive director that:
- (1) the ground-water is additionally contaminated by substances that have originated from a source other than a MSWLF unit and those substances are present in concentrations such that cleanup of the release from the MSWLF unit would provide no significant reduction in risk to actual or potential receptors; or
  - (2) the constituent is present in ground water that is not currently or reasonably expected to be a source of drinking water and is not hydraulically connected with waters to which the constituent is migrating or is likely to migrate in a concentration that would exceed the ground-water protection standards established under §330.235(h) or (i) of this title (relating to Assessment Monitoring Program); or
  - (3) remediation of the release is technically impracticable; or
  - (4) remediation of the release results in unacceptable cross-media impacts.



(f) A determination by the executive director pursuant to subsection (e) of this section shall not affect the authority of the state to require the owner or operator to undertake source-control measures or other measures that may be necessary to eliminate or minimize further releases to the ground water, to prevent exposure to the ground water, or to remediate the ground water to concentrations that are technically practicable and that significantly reduce threats to human health or the environment.

**§330.238. Implementation of the Corrective Action Program.**

(a) Based on the schedule established under §330.237(d) of this title (relating to Selection of Remedy) for initiation and completion of remedial activities, the owner or operator shall:

(1) establish and implement a corrective action ground-water monitoring program that:

(A) at least meets the requirements of an assessment monitoring program under §330.235 of this title (relating to Assessment Monitoring Program);

(B) indicates the effectiveness of the corrective action remedy; and

(C) demonstrates compliance with ground-water protection standards pursuant to subsection (e) of this section;

(2) implement the corrective action remedy selected under §330.237 of this title (relating to Selection of Remedy); and

(3) take any interim measures necessary to ensure the protection of human health and the environment. Interim measures should, to the greatest extent practicable, be consistent with the objectives of and contribute to the performance of any remedy that may be required pursuant to §330.237 of this title (relating to Selection of Remedy). The following factors shall be considered by an owner or operator in determining if interim measures are necessary:

(A) time required to develop and implement a final remedy;

(B) actual or potential exposure of nearby populations or environmental receptors to hazardous constituents;

(C) actual or potential contamination of drinking-water supplies or sensitive ecosystems;

(D) further degradation of the ground water that may occur if remedial action is not initiated expeditiously;

(E) weather conditions that may cause hazardous constituents to migrate or be released;

(F) risks of fire or explosion, or potential for exposure to hazardous constituents as a result of an accident or failure of a container or handling system; and

(G) other situations that may pose threats to human health and the environment.

(b) An owner or operator may determine, based on information developed after implementation of the remedy has begun or other information, that compliance with requirements of §330.237(b) of this title (relating to Selection of Remedy) are not being achieved through the remedy selected. In such cases, the owner or operator shall, with approval of the executive director, implement other methods or techniques that could practicably achieve compliance with the requirements unless the owner or operator makes the determination under subsection (c) of this section and if it is approved by the executive director. Failure to obtain approval from the executive director for the other methods and techniques does not relieve the owner or operator of the burden to implement an acceptable remedy.

(c) If the owner or operator determines that compliance with requirements under §330.237(b) of this title (relating to Selection of Remedy) cannot be practically achieved with any currently available methods, the owner or operator shall:

(1) present to the executive director certification by a qualified ground-water scientist that compliance with requirements under §330.237(b) of this title (relating to Selection of Remedy) cannot be practically achieved with any currently available methods;

(2) implement alternate measures, with the approval of the executive director, to control exposure of humans or the environment to residual contamination, as necessary to protect human health and the environment;

(3) implement alternate measures, with the approval of the executive director, for control of the sources of contamination, or for removal or decontamination of equipment, units, devices, or structures that are technically practicable and consistent with the overall objective of the remedy; and

(4) owner or operator shall place a copy of all approved alternate measures in the operating record.

(d) All solid wastes that are managed pursuant to a remedy required under §330.237 of this title (relating to Selection of Remedy), or an interim measure required under subsection (a)(3) of this section, shall be managed in a manner that is protective of human health and the environment and that complies with applicable RCRA requirements.

(e) Remedies selected pursuant to §330.237 of this title (relating to Selection of Remedy) shall be considered complete when:

(1) the owner or operator complies with the ground-water protection standards established under §330.235(h) or (i) of this title (relating to Assessment Monitoring Program) at all

points within the plume of contamination that lies within or beyond the ground-water monitoring system established under §330.231(a) of this title (relating to Ground-Water Monitoring Systems);

(2) compliance with the ground-water protection standards established under §330.235(h) or (i) of this title (relating to Assessment Monitoring Program) has been achieved by demonstrating that concentrations of assessment constituents have not exceeded the ground-water protection standards for a period of three consecutive years, using the statistical procedures and performance standards in §330.233(g) and (h) of this title (relating to Ground-Water Sampling and Analysis Requirements). The executive director may specify an alternative length of time during which the owner or operator shall demonstrate that concentrations of assessment constituents have not exceeded the ground-water protection standards. The alternative length of time shall be based on:

- (A) extent and concentration of the release;
- (B) behavior characteristics of the hazardous constituents in the ground water;
- (C) accuracy of monitoring or modeling techniques, including any seasonal, meteorological, or other environmental variabilities that may affect the accuracy; and
- (D) characteristics of the ground water.

(3) All actions required to complete the remedy have been satisfied.

(f) Within 15 days of completion of the remedy, the owner or operator shall submit to the executive director and also place in the operating record a certification by a qualified ground-water scientist that the remedy has been completed in compliance with the requirements of subsection (e) of this section.

(g) Upon submittal of satisfactory certification of the completion of the corrective action remedy, the executive director may release the owner or operator from the requirements for financial assurance for corrective action under §330.284 of this title (relating to Financial Assurance for Corrective Action).

#### **§330.239. Ground-Water Monitoring at Type IV Landfills.**

(a) The requirements in this section apply to existing and future Type IV sites, as defined in §330.41(e) of this title (relating to Types of Municipal Solid Waste Facilities), except as provided in §330.3(e) of this title (relating to Applicability) and in subsection (b) of this section.

(b) At the discretion of the executive director, the owner or operator of a Type IV site may be required to install ground-water monitoring systems and to monitor on a regular basis the quality of ground water at the point of compliance.

(1) The factors to be considered by the executive director in determining the need for ground-water monitoring shall include: relationship of the site to drinking-water intakes (both surface

and subsurface); hydrogeology of the shallow water-bearing zones in the site area; use of shallow ground water in the site area; type of waste being or to be taken; types of liner; likelihood of leakage of contaminants from the site; and protection of human health and the environment.

(2) A ground-water monitoring system shall be installed in accordance with §330.231 of this title (relating to Ground-Water Monitoring Systems).

(3) Ground-water sampling and analysis requirements shall be in accordance with §330.233(a)-(e) of this title (relating to Ground-Water Sampling and Analysis Requirements).

(4) Each monitoring well or other sampling point shall be sampled annually, or on some other schedule but not less frequently than annually as determined by the executive director, for the following constituents: chloride, iron (dissolved), manganese (dissolved), cadmium (dissolved), zinc (dissolved), total dissolved solids, specific conductance (field and laboratory measurements), pH (field and laboratory measurements), non-purgeable organic compounds, (analysis of three replicate samples).

(5) Not later than 45 days after each sampling event, the owner or operator shall submit to the executive director for review and approval a report containing the results of the analyses.

(6) The executive director may require additional sampling, analyses of additional constituents, installation of additional monitoring wells or other sampling points, and/or other hydrogeological investigations if the facility appears to be contaminating the shallow water-bearing zone(s).

(7) If the facility is found to have contaminated or be contaminating the shallow water-bearing zone(s), the executive director may order corrective action appropriate to protect human health and the environment up to and including that in §§330.236-330.238 of this title (relating to Ground-Water Monitoring and Corrective Action).

#### **§330.240. Ground-Water Monitoring at Other Types of Landfills and Facilities.**

The executive director may establish ground-water monitoring requirements for landfills and facilities other than Type I or IV where site-specific conditions and operations have the potential for ground-water contamination.

#### **§330.241. Constituents for Detection Monitoring.**

Table 1 of this section contains 47 volatile organic compounds (VOCs) for which required analytical procedures provided in Environmental Protection Agency Report SW-846, "Test Methods for Evaluating Solid Waste," third edition, November 1986, as revised December 1987, include Method 8260, and 15 metals for which SW-846 provides either Method 6010 or a method from the 7000 series or methods. Common names of the VOCs are those widely used in government regulations, scientific publications, and commerce; synonyms exist for many of them. The Chemical Abstracts Service

TABLE 1.

Common Name	CAS RN
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Inorganic constituents:	
(1) Antimony	(Total)
(2) Arsenic	(Total)
(3) Barium	(Total)
(4) Beryllium	(Total)
(5) Cadmium	(Total)
(6) Chromium	(Total)
(7) Cobalt	(Total)
(8) Copper	(Total)
(9) Lead	(Total)
(10) Nickel	(Total)
(11) Selenium	(Total)
(12) Silver	(Total)
(13) Thallium	(Total)
(14) Vanadium	(Total)
(15) Zinc	(Total)
Organic constituents:	
(16) Acetone	67-64-1
(17) Acrylonitrile	107-13-1
(18) Benzene	71-43-2
(19) Bromochloromethane	74-97-5
(20) Bromodichloromethane	75-27-4
(21) Bromoform (tribromomethane)	75-25-2
(22) Carbon disulfide	75-15-0
(23) Carbon tetrachloride	56-23-5
(24) Chlorobenzene	108-90-7
(25) Chloroethane (ethyl chloride)	75-00-3
(26) Chloroform (trichloromethane)	67-66-3
(27) Dibromochloromethane (chlorodibromomethane)	124-48-1
(28) 1,2-Dibromo-3-chloropropane (DBCP)	96-12-8
(29) 1,2-Dibromoethane (ethylene dibromide, EDB)	106-93-4
(30) o-Dichlorobenzene (1,2-dichlorobenzene)	95-50-1
(31) p-Dichlorobenzene	

(1,4-dichlorobenzene)	106-46-7
(32) trans-1,4-Dichloro-2-butene	110-57-6
(33) 1,1-Dichloroethane (ethylidene chloride)	75-34-3
(34) 1,2-Dichloroethane (ethylene dichloride)	107-06-2
(35) 1,1-Dichloroethylene (1,1-dichloroethene, vinylidene chloride)	75-35-4
(36) cis-1,2-Dichloroethylene (cis-1,2-dichloroethene)	156-59-2
(37) trans-1,2-Dichloroethylene (trans-1,2-dichloroethene)	156-60-5
(38) 1,2-Dichloropropane (Propylene dichloride)	78-87-5
(39) cis-1,3-Dichloropropene	10061-01-5
(40) trans-1,3-Dichloropropene	10061-02-6
(41) Ethylbenzene	100-41-4
(42) 2-Hexanone (methyl butyl ketone)	591-78-6
(43) Methyl bromide (bromomethane)	74-83-9
(44) Methyl chloride (chloromethane)	74-87-3
(45) Methylene bromide (dibromomethane)	74-95-3
(46) Methylene chloride (dichloromethane)	75-09-2
(47) Methyl ethyl ketone (MEK, 2-butanone)	78-93-3
(48) Methyl iodide (iodomethane)	74-88-4
(49) 4-Methyl-2-pentanone (methyl isobutyl ketone)	108-10-1
(50) Styrene	100-42-5
(51) 1,1,1,2-Tetrachloroethane	630-20-6
(52) 1,1,2,2-Tetrachloroethane	79-34-5
(53) Tetrachloroethylene (tetrachloroethene, perchloroethylene)	127-18-4
(54) Toluene	108-88-3
(55) 1,1,1-Trichloroethane (methychloroform)	71-55-6
(56) 1,1,2-Trichloroethane	79-00-5
(57) Trichloroethylene (trichloroethene)	79-01-6

(58) Trichlorofluoromethane (CFC-11)	75-69-4
(59) 1,2,3-Trichloropropane	96-18-4
(60) Vinyl acetate	108-05-4
(61) Vinyl chloride	75-01-4
(62) Xylenes	1330-20-7

**§330.242. Monitor-Well Construction Specifications.**

(a) The following specifications shall be used for the installation of ground-water monitoring wells at municipal solid-waste landfills. Equivalent alternatives to these specifications may be used if prior written approval is obtained in advance from the executive director.

(1) Drilling.

(A) Monitoring wells shall be drilled by a Texas-licensed driller who is qualified to drill and install monitoring wells. The installation and development must be supervised by a qualified geologist or engineer who is familiar with the geology of the area.

(B) The well shall be drilled by a method that will allow installation of the casing, screen, etc., and that will not introduce contaminants into the borehole or casing. Drilling techniques used for boring shall take into account the materials to be drilled, depth to ground water, total depth of the hole, adequate soil sampling, and other such factors that affect the selection of the drilling method. If any fluids are necessary in drilling or installation, then clean, treated city water shall be used; other fluids must be approved in writing by the executive director before use. If city water is used, a current chemical analysis of the city water shall be provided with the monitor-well report.

(C) The diameter of the boring shall be at least four inches larger than the diameter of the casing. When the boring is in hard rock, a smaller annulus may be approved by the executive director.

(D) During drilling of the monitoring well, a log of the boring shall be made by a qualified geologist or engineer who is familiar with the geology of the area.

(2) Casing, screen, filter pack, and seals.

(A) The well casing shall be: two to four inches in diameter; NSF-certified PVC schedule 40 or 80 pipe, flush-thread, screw joint (no glue or solvents); polytetrafluorethylene (PTFE, such as Teflon) tape or O-rings in the joints; no collar couplings. The top of the casing shall be at least two feet above ground level. Where high levels of volatile organic compounds or corrosive compounds are anticipated, stainless steel or PTFE casing and screen may be used, subject to approval by the executive director. Four-inch diameter casing is recommended because it allows larger volume samples to be obtained and provides easier access for development, pumps, and repairs. The casing shall be cleaned and packaged at the place of manufacture; the packaging shall include a PVC wrapping

on each section of casing to keep it from being contaminated prior to installation. The casing shall be free of ink, labels, or other markings. The casing (and screen) shall be centered in the hole to allow installation of a good filter pack and annular seal, using appropriately placed centralizers. The top of the casing shall be protected by a threaded or slip-on top cap or by a sealing cap or screw-plug seal inserted into the top of the casing. The cap shall be vented to prevent buildup of methane or other gases and shall be designed to prevent moisture from entering the well.

(B) The screen shall be compatible with the casing and should generally be of the same material. The screen shall not involve the use of any glues or solvents for construction. A wire-wound screen is recommended to provide maximum inflow area. Field-cut slots are not permitted for well screen. Filter cloth shall not be used. A blank-pipe sediment trap, typically one to two feet, should be installed below the screen. A bottom cap is typically placed on the bottom of the sediment trap. The sediment trap shall not extend through the lower confining layer of the water-bearing zone being tested. Screen sterilization methods are the same as those for casing. Selection of the size of the screen opening should be done by a person experienced with such work and shall include consideration of the distribution of particle sizes both in the water-bearing zone and in the filter pack surrounding the screen. The screen opening shall not be larger than the smallest fraction of the filter pack.

(C) The filter pack, placed between the screen and the well bore, shall consist of pre-packaged, inert, clean silica sand or glass beads; it shall extend from one to four feet above the top of the screen. Open stockpile sources of sand or gravel are not permitted. The filter pack usually has a 30% finer grain size that is about four to 10 times larger than the 30% finer grain size of the water-bearing zone; the filter pack should have a uniformity coefficient less than 2.5. The filter pack should be placed with a tremie pipe to ensure that the material completely surrounds the screen and casing without bridging. The tremie pipe shall be steam cleaned prior to the first well and before each subsequent well.

(D) The annular seal shall be placed on top of the filter pack and shall be at least two feet thick. It should be placed in the zone of saturation to maintain hydration. The seal should be composed of coarse-grain sodium bentonite, coarse-grit sodium bentonite, or bentonite grout. Special care should be taken to ensure that fine material or grout does not plug the underlying filter pack. Placement of a few inches of pre-packaged clean fine sand on top of the filter pack will help to prevent migration of the annular seal material into the filter pack. The seal should be placed on top of the filter pack with a steam-cleaned tremie pipe to ensure good distribution and should be tamped with a steam-cleaned rod to determine that the seal is thick enough. The bentonite shall be hydrated with clean water prior to any further activities on the well and left to stand until hydration is complete (eight to 12 hours, depending on the grain size of the bentonite). If a bentonite-grout (without cement) casing seal is used in the well bore, then it may replace the annular seal described above.

(E) A casing seal shall be placed on top of the annular seal to prevent fluids and contaminants from entering the borehole from the surface. The casing seal shall consist of a commercial bentonite grout or a cement-bentonite mixture. Drilling spoil, cuttings, or other native materials are not permitted for use as a casing seal. Quick-setting cements are not permitted for use because contaminants may leach from them into the ground water. The top of the casing seal shall be between five and two feet from the surface.



(3) Concrete pad. High-quality structural-type concrete shall be placed from the top of the casing seal (two to five feet below the surface) continuously to the top of the ground to form a pad at the surface. This formed surface pad shall be at least six inches thick and not less than four (preferably six) feet square or five (preferably six) feet in diameter. The pad shall contain sufficient reinforcing steel to ensure its structural integrity in the event that soil support is lost. The top of the pad shall slope away from the well bore to the edges to prevent ponding of water around the casing or collar.

(4) Protective collar. A steel protective pipe collar shall be placed around the casing "stickup" to protect it from damage and unwanted entry. The collar shall be set at least one foot into the surface pad during its construction and should extend at least three inches above the top of the well casing (and top cap, if present). The top of the collar shall have a lockable hinged top flap or cover. A sturdy lock shall be installed, maintained in working order, and kept locked when the well is not being bailed/purged or sampled. The well number or other designation shall be marked permanently on the protective steel collar; it is useful to mark the total depth of the well and its elevation on the collar.

(5) Protective barrier. Where monitoring wells are likely to be damaged by moving equipment or are located in heavily traveled areas, a protective barrier shall be installed. A typical barrier is three or four six-to 12-inch diameter pipes set in concrete just off the protective pad. The pipes can be joined by pipes welded between them, but consideration must be given to well access for sampling and other activities. Separation of such a pipe barrier from the pad means that the barrier can be damaged without risk to the pad and well. Other types of barriers may be approved by the executive director.

(b) Unusual conditions. Where monitoring wells are installed in unusual conditions, all aspects of the installation shall be approved in writing in advance by the executive director. Such aspects include, for example, the use of cellar-type enclosures for the top-well equipment or multiple completions in a single hole.

(c) Development. After a monitoring well is installed, it shall be developed to remove artifacts of drilling (clay films, bentonite pellets in the casing, etc.) and to open the water-bearing zone for maximum flow into the well. Development should continue until all of the water used or affected during drilling activities has been removed and field measurements of pH, specific conductance, and temperature have stabilized. Failure to develop a well properly may mean that it is not properly monitoring the water-bearing zone or may not yield adequate water for sampling even though the water-bearing zone is prolific.

(d) Location and elevation. Upon completion of a monitoring well, the location of the well and all appropriate elevations associated with the top-well equipment shall be surveyed by a registered professional surveyor or a registered professional engineer. The elevation shall be surveyed to the nearest 0.01 foot above mean sea level (with year of the sea-level datum shown). The point on the well casing for which the elevation was determined shall be permanently marked on the casing. The location shall be given in terms of the latitude and longitude at least to the nearest tenth of a second or shall be accurately located with respect to the landfill grid system described in §330.55(a)(10)(F) of this title (relating to Site Development Plan).

(e) Reporting. Monitoring well installation and construction details shall be submitted on forms available from the commission and shall be completed and submitted within 30 days of well completion. A copy of the detailed geologic log of the boring, any particle size or other sample data from the well, and a site map drawn to scale showing the location of all monitoring wells shall be submitted to the executive director at the same time. The licensed driller should be familiar with the forms required by other agencies; a copy of those forms shall also be submitted to the commission.

(f) Damaged wells. Any monitoring well that is damaged to the extent that it is no longer suitable for sampling shall be reported to the executive director who may make a determination about whether to repair or replace the well.

(g) Plugging and abandonment. Any monitoring well that is no longer used shall be properly abandoned and plugged in accordance with 31 TAC 338.48 of this title (relating to Well Plugging and Capping). No abandonment shall take place without prior authorization in writing by the executive director.